UNITED STATES PATENT AND TRADEMARK OFFICE

UNITED STATES DEPARTMENT OF COMMERCE
United States Patent and Trademark Office
Address: COMMISSIONER FOR PATENTS
P.O. Box 1450
Alexandria, Virginia 22313-1450
www.uspto.gov

APPLICATION NO.	FILING DATE	FIRST NAMED INVENTOR	ATTORNEY DOCKET NO.	CONFIRMATION NO.
10/566,858	10/05/2006	Tiow Seng Tan	57090/C982	2245

23363 7590 02/03/2010
CHRISTIE, PARKER & HALE, LLP
PO BOX 7068
PASADENA, CA 91109-7068

EXAMINER	
MEROUAN, ABDERRAHIM	

ART UNIT	PAPER NUMBER
2628	

MAIL DATE	DELIVERY MODE
02/03/2010	PAPER

Please find below and/or attached an Office communication concerning this application or proceeding.

The time period for reply, if any, is set in the attached communication.

Office Action Summary	**Application No.** 10/566,858	**Applicant(s)** TAN ET AL.	
	Examiner ABDERRAHIM MEROUAN	**Art Unit** 2628	

-- The MAILING DATE of this communication appears on the cover sheet with the correspondence address --

Period for Reply

A SHORTENED STATUTORY PERIOD FOR REPLY IS SET TO EXPIRE *3* MONTH(S) OR THIRTY (30) DAYS, WHICHEVER IS LONGER, FROM THE MAILING DATE OF THIS COMMUNICATION.

- Extensions of time may be available under the provisions of 37 CFR 1.136(a). In no event, however, may a reply be timely filed after SIX (6) MONTHS from the mailing date of this communication.
- If NO period for reply is specified above, the maximum statutory period will apply and will expire SIX (6) MONTHS from the mailing date of this communication.
- Failure to reply within the set or extended period for reply will, by statute, cause the application to become ABANDONED (35 U.S.C. § 133). Any reply received by the Office later than three months after the mailing date of this communication, even if timely filed, may reduce any earned patent term adjustment. See 37 CFR 1.704(b).

Status

1)☒ Responsive to communication(s) filed on *22 October 2009*.

2a)☒ This action is **FINAL**. 2b)☐ This action is non-final.

3)☐ Since this application is in condition for allowance except for formal matters, prosecution as to the merits is closed in accordance with the practice under *Ex parte Quayle*, 1935 C.D. 11, 453 O.G. 213.

Disposition of Claims

4)☒ Claim(s) *1-22* is/are pending in the application.

4a) Of the above claim(s) _____ is/are withdrawn from consideration.

5)☐ Claim(s) _____ is/are allowed.

6)☒ Claim(s) *1-22* is/are rejected.

7)☐ Claim(s) _____ is/are objected to.

8)☐ Claim(s) _____ are subject to restriction and/or election requirement.

Application Papers

9)☐ The specification is objected to by the Examiner.

10)☐ The drawing(s) filed on *31 January 2006* is/are: a)☒ accepted or b)☐ objected to by the Examiner.

Applicant may not request that any objection to the drawing(s) be held in abeyance. See 37 CFR 1.85(a).

Replacement drawing sheet(s) including the correction is required if the drawing(s) is objected to. See 37 CFR 1.121(d).

11)☐ The oath or declaration is objected to by the Examiner. Note the attached Office Action or form PTO-152.

Priority under 35 U.S.C. § 119

12)☐ Acknowledgment is made of a claim for foreign priority under 35 U.S.C. § 119(a)-(d) or (f).

a)☐ All b)☐ Some * c)☐ None of:

1.☐ Certified copies of the priority documents have been received.

2.☐ Certified copies of the priority documents have been received in Application No. _____.

3.☐ Copies of the certified copies of the priority documents have been received in this National Stage application from the International Bureau (PCT Rule 17.2(a)).

* See the attached detailed Office action for a list of the certified copies not received.

Attachment(s)

1) ☒ Notice of References Cited (PTO-892)

2) ☐ Notice of Draftsperson's Patent Drawing Review (PTO-948)

3) ☐ Information Disclosure Statement(s) (PTO/SB/08) Paper No(s)/Mail Date _____.

4) ☐ Interview Summary (PTO-413) Paper No(s)/Mail Date. _____ .

5) ☐ Notice of Informal Patent Application

6) ☐ Other: _____.

DETAILED ACTION

Claim Rejections - 35 USC § 102

1. The following is a quotation of the appropriate paragraphs of 35 U.S.C. 102 that form the basis for the rejections under this section made in this Office action:

> A person shall be entitled to a patent unless –
>
> (a) the invention was known or used by others in this country, or patented or described in a printed publication in this or a foreign country, before the invention thereof by the applicant for a patent.

2. Claims 1-19, and 21-22 are rejected under 35 U.S.C. 102(a) as being anticipated by Brabec et al (NPL: Practical Shadow Mapping) hereinafter referred as Brabec.

3. As per claim 1, Brabec discloses: A method of real-time shadow generation in computer graphical representation of a scene (Brabec, Page1, Introduction, lines 1-3" ... ***shadow techniques used for real time rendering***..."), the method comprising: defining an eye's frustum based on a desired view of the scene (Brabec, Page 2, Introduction, lines 1-5" ...***the light source's viewing frustum can be adjusted to use the most*** ...");
defining a location of a light source illuminating at least a portion of the scene (Brabec, Page 4, How near, how far, lines 1-2" ...***the setting of the near and far when rendering from the light source position*** ...");
generating a trapezoid to approximate an area, E, within the eye's frustum in a post- perspective

space of a light, L (Brabec, Page 4, How near, how far? , " ***The figure 3 shows the area delimited between the near plan and far plan such that all relevant objects are inside the light's viewing frustum, this are has a shape of trapezoid as depicted in Figure 3***");
applying a trapezoidal transformation to objects within the trapezoid into a trapezoidal space for computing a shadow map (Brabec, Page 3, Distribution of depth values, lines 24-26" ***... vertex transformation , which can be implemented using the so called vertex shader program*** ...");
and determining whether an object or part thereof is in shadow in the desired view of the scene utilizing the computed shadow map (Brabec, Page 6, Concentrating on the visible part, lines 10-15" ***... In order to compute the visible pixels...***");.

4. As per claim 2, Brabec discloses: The method as claimed in claim 1, wherein generating the **trapezoid comprises generating** top and base lines l_t and l_b, respectively, of the trapezoid to approximate E in L, and:

- computing a centre line l, which passes through centres of near and far planes of E (Brabec, Page 3, Distribution of depth values, lines 27-28 "***... homogeneous P...***");
- calculating 2D convex hull of E (Brabec, Page 6, Optimal bounding rectangle, lines 3-4 "***... We start by computing the two dimension convex hull...***");
-calculating a l_t that is orthogonal to l and touches the boundary of the convex hull of E (Brabec, Page 4, How near, how far, lines 1-5 "***... setting the near and far plan (far plan corresponds to the top line)...***"); and
-calculating a lb which is parallel to It and touches the boundary of the convex hull of E (Brabec, Page 4, How near, how far, lines 1-5 "***... setting the near plan (far plan corresponds to thee***

base line) and far...");

.

5. As per claim 3, Brabec discloses: The method as claimed in claim 1, wherein, in the case that the canters of the far and near planes or E are substantially coincident, a smallest box bounding the far plane is defined as the trapezoid (Brabec, Page 7, Optimal bounding rectangle, lines 6-8"***... to find the optimal bounding rectangle...***");

.

6. As per claim 4, Brabec discloses: The method as claimed in claim 1, wherein generating the side lines of the trapezoid to approximate E in L comprises:

- assigning a distance δ from the near plane of the eye's frustum to define a focus region in a desired view of the scene (Brabec, Page 3, Distribution of the depth values, Figure 2);
- determining a point pl in L that lies on l at the distance δ from the near plane of the eye's frustum (Brabec, Page 3, Distribution of the depth values, lines 27-30"***...homogeneous point P...***");
- computing the position of a point q on 1, wherein q is the centre of a projection to map the base line and the top line of the trapezoid to y = -1 and y = +1 respectively, and to map PL to a point on y = ξ, with ξ between -1 and +1 (Brabec, Page 6, Axis aligned bounding rectangle, lines 1-6" and , Concentrating on the visible part, lines 10-15);
-constructing two side lines of the trapezoid each passing through q, wherein each sideline touches the 2D convex hull of E on respective sides of l (Brabec, Page 6, Optimal bounding rectangle, lines 1-5"***...homogeneous point P...***");

.

7. As per claim 5, Brabec discloses: The method as claimed in claim 4, wherein ξ = -0.6. (Brabec, Page 6, Axis aligned bounding rectangle, lines 1-6, and Page 3 Figure 2, "the user can choose any line to clip between -1 and +1");

8. As per claim 6, Brabec discloses: The method as claimed in claim 4, wherein the desired point ξ is determined based on an iterative process that minimizes wastage (Brabec, Page 3, Distribution of depth values, lines 27-31"***... the linear depth value z1....***")

9. As per claim 7, Brabec discloses: The method as claimed in claim 6, wherein the iterative process is stopped when a local minimum is found (Brabec, Page 3, Distribution of depth values, lines 5-7)

10. As per claim 8, Brabec discloses: The method as claimed in claim 6, wherein the iterative process is pre-computed and the results are stored in a table for direct reference. (Brabec, Page 5, How near, how far, lines 30-33 "***This way all vertices are forced to lie between ...***")

11. As per claim 9, Brabec discloses: The method as claimed in claim 1, further comprising:
- determining an intersection I, between the light source's frustum and the eye's frustum (Brabec, Page 3, Figure 2);
- computing the centre point e of the vertices of I (Brabec, Page 3, Distribution of depth values, lines 23 -26)

- defining a centre line In passing through the position of the eye and e, for generating the trapezoid (Brabec, Page 6, Optimal bounding rectangle, lines 1-5).

12. As per claim 10, Brabec discloses: The method as claimed in claim 9, further comprising defining a new focus region which lies between the near and far planes of the eye's frustum that are geometrically pushed closer to tightly bound L (Brabec, Page 4, How near how far, Figure 3)

13. As per claim 11, Brabec discloses: The method as claimed in claim 1, wherein the trapezoidal transformation comprises mapping the four corners of the trapezoid to a unit square that is the shape of a square shadow map, or to a general rectangle that is the shape of a rectangular shadow map (Brabec, Page 7, Result, lines 6-8 , and Page 8, lines 1-5)

14. As per claim 12, Brabec discloses: The method as claimed in claim 11, wherein the size of the square or general rectangle changes based on a configuration of the light source and the eye (Brabec, Page 6, Concentrating on the visible part, lines 1-8).

15. As per claim 13, Brabec discloses: The method as claimed in claim 1, wherein the trapezoidal transformation transforms only the x and the y values of a vertex from the post-perspective space of the light to the trapezoidal space, while the z value is maintained at the value in the post-perspective space of the light (Brabec, Page 6, Optimal bounding rectangle, lines 1-5 , and Page 7, lines 1-5).

16. As per claim 14, Brabec discloses: The method as claimed in claim 13, further comprising applying the trapezoidal transformation to obtain the x, y, and w values in the trapezoidal space, Xt, Yt, and Wt, and computing the z value in the trapezoidal space, Zt, as Zt= (Zl*Wt)/Wl where Zl and Wl, are the z and w values in the post-perspective space of the light, respectively (Brabec, Page 3, Distribution of depth value, lines 27-34 " "***Instead of transforming...***)..

17. As per claim 15, Brabec discloses: The method as claimed in claim 13, further comprising:

- in a first pass of shadow map generation, transforming coordinate values of a fragment from the trapezoidal space back into the post-perspective space L of the light to obtain a first transformed fragment (Brabec, Page 1, Introduction, lines 10-12, and Page ,lines 1-5), utilizing the plane equation of the first transformed fragment to compute a distance value of the first transformed fragment from the light source in L, ZLI, adding an offset value to ZLI, (Brabec, Page 7, Optimal bounding rectangle, lines 1-5)and store the resulting value as a depth value in the shadow map (Brabec, Page 2, Introduction, lines 8-15); and
- in a second pass of shadow determination,

transforming texture coordinate assigned, through projective texturing, to the fragment from the trapezoidal space back into L (Brabec, Page 2, Introduction, lines 36-37), obtaining a second transformed fragment from the transformed texture coordinate, utilizing the plane equation of - the second transformed fragment to compute a distance value of the second transformed fragment from the light source in L, ZL2, and determine whether the fragment is in shadow

based on a comparison of the stored depth value in the shadow map and ZL2 (Brabec, Page 2, Introduction, lines 37-41), .

18. As per claim 16, Brabec discloses: The method as claimed in claims 13, further comprising:

- in a first pass of shadow map generation, during a vertex stage, transforming coordinate values of the vertex into the trapezoidal space, and assigning to the vertex the texture coordinate equal to the vertex's coordinate values in the post-perspective space of the light , (Brabec, Page 2, Introduction, lines 30-41) and
- during a fragment stage, replacing the depth of the fragment with the texture coordinate of the fragment, adding to the depth an offset, (Brabec, Page 4, How near how far , lines 26-29) and store the resulting value as a depth value in the shadow map (Brabec, Page 2, Introduction, lines 37-41)
- in a second pass of shadow determination,
- during the vertex stage, transforming coordinate values of the vertex into the post-perspective space of the eye, and assigning to the vertex two texture coordinates that are first the coordinate values of the vertex in the post- perspective space of the light and second the coordinate values of the vertex in the trapezoidal space (Brabec, Page 5, lines 26-33)
- during the fragment stage, determining shadow of the fragment based on a comparison of the stored depth value in the shadow map, as indexed based on the second texture coordinate of the fragment, with a value based on the first texture coordinate of the fragment. (Brabec, Page 2, Introduction, lines 37-41)

19. As per claims 17-18, the arguments used to reject claims 15-16 are the same arguments used to reject claims 17-18.

20. As per claim 19, Brabec discloses: The method as claimed in claim 1, further comprising adding a polygon offset in the determining whether an object or part thereof is in shadow in the desired view of the scene for representation utilizing the computed shadow map . (Brabec, Page 6, concentrating on the visible part, lines 4-20)

21. As per claims 21-22, the arguments used to reject claim 1 are the same arguments used to reject claims 21-22.

Claim Rejections - 35 USC § 103

22. The following is a quotation of 35 U.S.C. 103(a) which forms the basis for all obviousness rejections set forth in this Office action:

> (a) A patent may not be obtained though the invention is not identically disclosed or described as set forth in section 102 of this title, if the differences between the subject matter sought to be patented and the prior art are such that the subject matter as a whole would have been obvious at the time the invention was made to a person having ordinary skill in the art to which said subject matter pertains. Patentability shall not be negatived by the manner in which the invention was made.

23. Claim 20 is rejected under 35 U.S.C. 103(a) as being unpatentable over by Brabec et al (NPL: Practical Shadow Mapping) hereinafter referred as Brabec in view of Corbeta (US Patent 6903741 B2), hereinafter referred as Corbeta.

24. As per claim 20, Brabec discloses: The method as claimed in claim 1,
Brabec doesn't disclose: wherein two or more light sources illuminate at least respective portions of the scene, and the method is applied for each light source. However, Corbeta discloses: wherein two or more light sources illuminate at least respective portions of the scene, and the method is applied for each light source (Brabec, Page 10, ***e.g. light sources far away from the regions of interest in the scene to be rendered***, lines 33-38)

It would have been obvious to one skilled in the art, at the time of the Applicant's invention, to incorporate the teachings of Corbeta into the process taught by Brabec, because through such incorporation would provide a faster rendering.

Response to Arguments

25. Applicant's arguments directed to claims 1-22 have been fully considered but they are not persuasive.

26. In response to applicant's argument for claim 1, applicant argues on page 9 that the prior art doesn't disclose:" ... using a trapezoid for approximating an area, or any trapezoidal transformation of objects within a trapezoid into a trapezoidal space, for computing a shadow map. " Examiner respectfully disagrees with the argument because Brabec stated that: " *...We can achieve this linear distribution of depth values using a customized vertex transformation, which can be implemented using the so called vertex shader or vertex program functionality [available on all recent graphics cards. Instead of transforming all components of a homogeneous point P =(xe, ye, ze, we) by the perspective transformation matrix, e.g. (x, y, z, w)= Lightproj * P, we replace the z component by a new value* $z^{l} = zl \bullet w$. *The linear depth value zl ϵ [0; 1] corresponds to the eye space value ze mapped according to the light source near and fax plane:* (Barbec Page 3, " *Distribution of the depth values."),* also (see Brabec, Page 4, How near, how far? , " ***The figure 3 shows the area delimited between the near plan and far plan such that all relevant objects are inside the light's viewing frustum, this are has a shape of trapezoid as depicted in Figure 3*** ");

27. In response to applicant's argument for claim 2, applicant argues on page 10 that the combination of the prior art doesn't disclose: "computing a centre line l, which passes through centers of near and far planes of E." Examiner respectfully disagrees with the argument because Brabec stated that: "*...a homogeneous point P =(xe, ye, ze, we) by the perspective transformation matrix, e.g. (x, y, z, w)= Lightproj * P"* (Brabec, Page 3, Distribution of depth values, lines 27-28 "*By projecting P along axis Z (depth) we can construct a line.* ")

calculating 2D convex hull of E (Brabec, Page 6, Optimal bounding rectangle, lines 3-4 "... *We start by computing the two dimension convex hull...*" also see Axis aligned rectangle : Page 6 , lines 4-7 "*This bounding rectangle can now be used to focus the shadow map on the visible pixels in the scene. All we have to do is to perform a scale and bias on the x and y coordinates after the light's projection matrix.... Ymin is Lb and Ymax is Lt* ").

28. In response to applicant's argument for claim 3,on page 10 , that of the prior art doesn't disclose: "smallest box bounding a far plane is defined as trapezoid" ." Examiner respectfully disagrees with the argument because Brabec stated that: " *Figure 2 Left shows that the depth values are uniformly distributed between the near and the far plane forming many bounding box as trapezoid in deferent size and by approaching the far plan the depth value is the smallest value and form the smallest bounding box.* ")

29. The argument used to respond the claim2 are the same arguments for claim 4.

30. In response to applicant's argument for claim 8,on page 12 , that the prior art doesn't disclose: "iterative process is pre-computed and the results are stored in a table for direct reference". Examiner respectfully disagrees with the argument because Brabec stated that: "*Assume we want to render(compute)) a shadow map with 16 bit precision where depth values outside the valid range axe clamped rather than clipped away. These depth values can be encoded using two bytes, where one contains the least significant bits (LSB) while*

the other stores the most significant bits (MSB) (storage could be a table) (Brabec, Page 5, How near, how far.)

31. In response to applicant's argument for claim 9,on page 12-13 , that the prior art doesn't disclose : "determining an intersection I, between the light source's frustum and the eye's frustum. And computing the centre point c of the vertices of I " Examiner respectfully disagrees with the argument because Brabec stated that:" *Figure 2 show all the point of intersection between the light and the camera* " (Brabec, Page 3, Figure 2);

32. In response to applicant's argument for claim 13,on page 13 , that the prior art doesn't disclose : " the generation of the rectangle is directed at x and values only" Examiner respectfully disagrees with the argument because Brabec stated that:" the point P depends on x, y and z (Brabec , Page 3, Distribution of depth values).

33. In response to applicant's argument for claim 20, on page 12-13. The same arguments used for claim 1 is used for the applicant's argument for claim 20.

Conclusion

34. **THIS ACTION IS MADE FINAL.** Applicant is reminded of the extension of time policy as set forth in 37 CFR 1.136(a).

A shortened statutory period for reply to this final action is set to expire THREE MONTHS from the mailing date of this action. In the event a first reply is filed within TWO MONTHS of the mailing date of this final action and the advisory action is not mailed until after the end of the THREE-MONTH shortened statutory period, then the shortened statutory period will expire on the date the advisory action is mailed, and any extension fee pursuant to 37 CFR 1.136(a) will be calculated from the mailing date of the advisory action. In no event, however, will the statutory period for reply expire later than SIX MONTHS from the mailing date of this final action.

Any inquiry concerning this communication or earlier communications from the examiner should be directed to ABDERRAHIM MEROUAN whose telephone number is (571)270-5254. The examiner can normally be reached on Monday to Friday 7:30 AM to 5:00 PM.

If attempts to reach the examiner by telephone are unsuccessful, the examiner's supervisor, Xiao Wu can be reached on **(571) 272-7761**. The fax phone number for the organization where this application or proceeding is assigned is 571-273-8300.

Information regarding the status of an application may be obtained from the Patent Application Information Retrieval (PAIR) system. Status information for published applications may be obtained from either Private PAIR or Public PAIR. Status information for unpublished applications is available through Private PAIR only. For more information about the PAIR system, see http://pair-direct.uspto.gov. Should you have questions on access to the Private PAIR system, contact the Electronic Business Center (EBC) at 866-217-9197 (toll-free). If you would like assistance from a USPTO Customer Service Representative or access to the automated information system, call 800-786-9199 (IN USA OR CANADA) or 571-272-1000.

/Abderrahim Merouan/

Examiner, Art Unit 2628

/XIAO M. WU/

Supervisory Patent Examiner, Art Unit 2628